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WAYS TO IMPROVE THE PROCESS OF DESIGNING PROTECTIVE CLOTHING FOR SURGEONS

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Abstract

The article deals with improving ergonomics and barrier efficiency of medical clothing by improving its design process in the context of Ukrainian industrial enterprises. The results of the analysis of qualitative characteristics of medical clothing used by surgeons during operations have been presented. In order to create more sophisticated clothing for surgeons, it has been suggested to apply a comprehensive approach to the formation of consumer requirements on a "general to individual" basis at the stage of pre-design studies. The application of the proposed approach in the requirements development to create surgical coats with improved protective properties has been described.

Keywords: protective clothing, medical clothing, clothing requirements, surgical coat, clothing design, ergonomic design.

Medicine is a practical activity that is related to the elimination of pathological processes in the human body and to the health improvement through the use of modern treatments and medical technologies. One of these is surgery. It is undeniable that surgery refers to clean technologies that are carried out in clean rooms with regulated levels of concentration of biological microorganisms and particles in the air [1-3]. Therefore, the main task is to ensure the simultaneous protection of the patient's body and the surgeon from the products of vital activity, individual micro-flora, biological material and pathogenic bacteria. It is well known that such barrier functions must be performed by personal protective means, which includes special clothing. Along with the barrier function, the surgeon's clothing must provide a comfortable micro-climate in the underwear area, creating the most favorable conditions for his professional activity.

The barrier effectiveness of surgical coats has been highlighted in the works of leading scientists such as W. Beck, H. Laufman, R. Nichols, and others [4-6]. The main principles and approaches to the design of protective clothing of various functional directions, including ones with barrier properties, are outlined in the works of M.P. Bereznenko, S.M. Bereznenko, N.P. Suprun, V.I. Vlasenko, M.V. Kolosnichenko, N.V. Ostapenko, G.V. Shchutskaya and others [7-9]. However, the issue of creating effective protection for medical staff in surgical wards is still relevant.

Therefore, designing protective medical barrier clothing for surgery staff to meet conflicting requirements is a complex and responsible task that requires a comprehensive approach to design and scientifically validated parameterization.

The purpose of this work is to improve the process of designing barrier clothing for surgeons with predicted reliability and ergonomics. The object of the study is the process of designing protective barrier clothing with improved quality. The subject of the study is the process of designing surgical coats.

Medical staff treat their patients, but they themselves fall victims to many harmful and dangerous factors. Strenuous work, interaction with patients, dangerous biological and chemical substances, etc., have a negative impact on the health of physicians [10, 11]. But it should be noted that it is the surgeons who directly carry out surgical interventions in the patient's body, that leads to the patient's anatomical violation, separation, movement and connection of the integrity of the soft tissues and organs. This is accompanied by excessive discharge of biological fluid and contamination of the patient's special clothing and gloves with the patient's biological material. Surgeons need the most effective barrier protection, therefore, their working conditions have been considered in more detail (Fig. 1).

Fig. 1. Surgeon's working zone

Analyzing the means of individual protection that surgeons use during the operation, it has been established that they include helmets, masks, gloves, shoe covers and special clothing, which consists of a surgical suit and a medical coat (Fig. 1).

In order to establish the real state of providing surgeons of state medical institutions with special clothing, a questionnaire has been conducted. The survey has been conducted among medical staff in the surgical departments of Ivano-Frankivsk, Kirovograd, Kyiv regions and regional centers of Ukraine. The survey has been attended by more than 250 medical professionals of surgeries. As a result of the survey, it has been found that most often (90% of respondents responded positively (Figs. 2, 3)) in reductive surgery coats made of cotton or mixed fabrics are used in public medical institutions; 83% of respondents found the main disadvantage of reusable medical coats — penetration of the patient's biological fluid into the underarm space and contamination of the inner layers of the surgeon's clothing package. To protect against penetration of the patient's biological material into the surgeon's dressing area the physicians additionally use an apron of hospital sheeting (confirmed by 29% of respondents), of which 50% of respondents mentioned the inconvenience of using this additional protection; 80% of respondents noted an increase in sweating while using surgical clothing made of mixed and artificial fabrics; 85% of respondents indicated that they had experience in using disposable surgical coats, of which almost 100% indicated discomfort after the first hour of operation (excessive sweating and fever in the underarm area). It should be noted that the renewal of reusable surgical clothing is carried out on the assumption of unfit for use (mechanical destruction of the material).

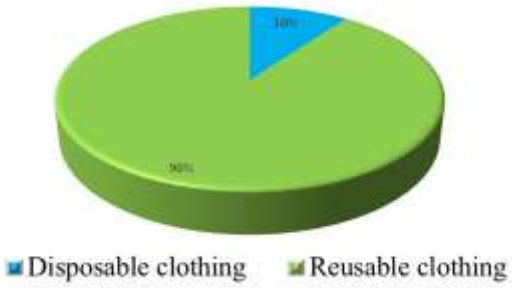

Fig. 2. Diagram of the distribution of the use of surgical coats

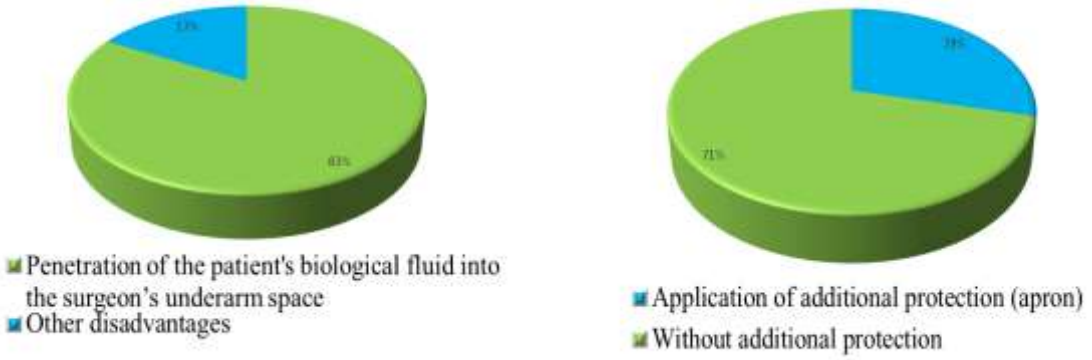

Fig. 3. Diagram of the major, indicated by surgeons, disadvantages of reusable medical coats and the use of additional protection (aprons)

Therefore, according to the survey, for the workers of the surgical departments of Ukrainian state healthcare institutions reusable medical clothing from cotton and mixed fabrics are bought. Improvement of the barrier properties is ensured by the use of additional protective clothing items (over-sleeves and aprons).

According to a survey of operating unit health practitioners regarding the compliance of medical clothing with consumer requirements, it can be concluded that such clothing is not perfect in terms of hygiene and functionality because it has low protective properties in certain areas and locations of threaded joints of parts.

During the analysis of the manufacturing process of such clothing on the assumption of industrial enterprises of mass production, it has been found out that Ukrainian manufacturers of medical clothing use outdated approaches in its design, when the stage of predesign studies hidden consumer requirements are not set and not taken into account [12] and there is no stage of design development — concepts of creating more sophisticated types of clothing [13].

Taking into account all the above, it has been proposed to structure the consumer requirements for medical clothing and to design a comprehensive approach based on the principle "from general to individual", which is formalized in the form shown in Fig. 4.

Using the proposed principle, the requirements for the design of reusable surgical coats have been developed.

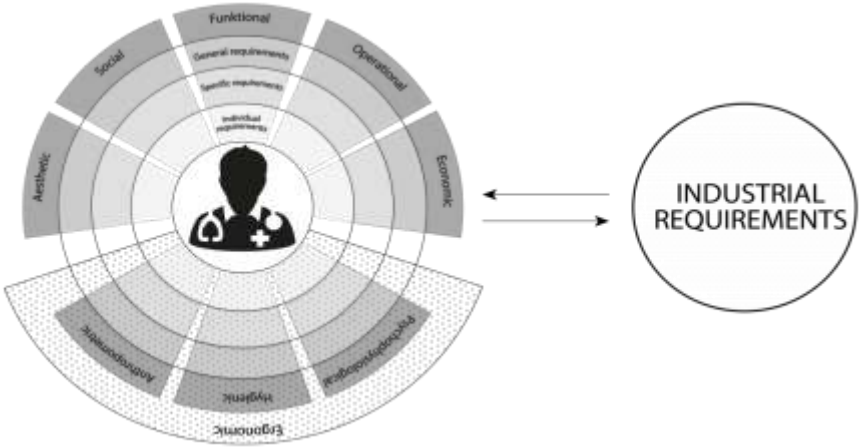

Fig. 4. Structuring the requirements according to the principle "from general to individual"

To establish specific requirements (Fig. 4) for the design of surgical coats, an ergonomic scheme of interaction of elements of the patient — surgeon — environment system has been developed (Fig. 5).

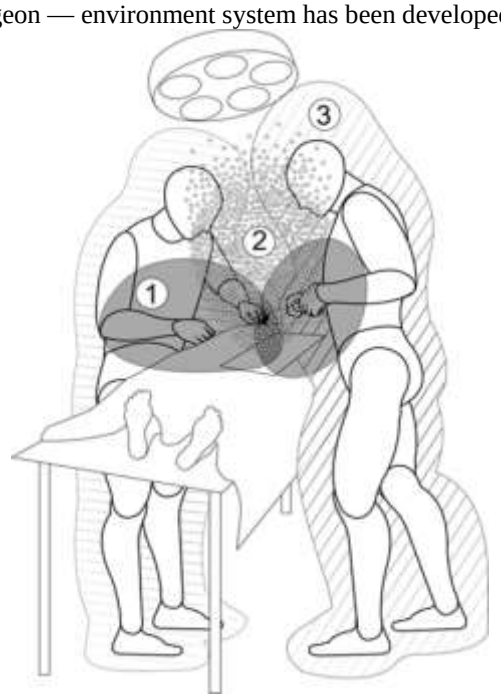

Fig. 5. Ergonomic scheme of the patient — surgeon — environment:
1 — the area of the greatest contamination with the patient's biological materials;
2 — the area of the greatest distance of the respiratory tract of surgeons to the air zone with the most concentrated bacterial contamination; 3 — distribution zone of surgeons' micro flora

In accordance with the developed ergonomic scheme (Fig. 5) and the structural diagram of the sections of the surgical coat (Fig. 6), which face the most dangerous factors, requirements for certain areas of medical coats that are related to the specifics of the surgeons' work have been established.

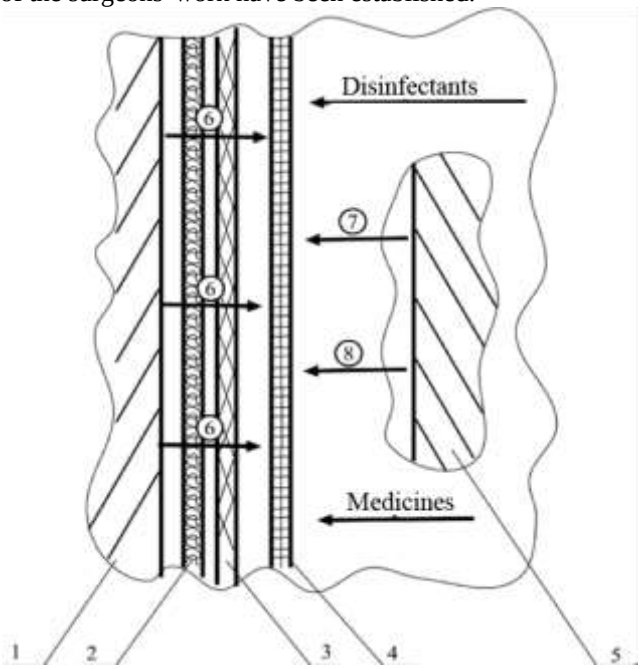

Fig. 6. Interaction of elements "surgeon — protective barrier clothing — environment in the area of the highest contamination": 1 — the surgeon's body; 2— a layer of underwear; 3 — layer of surgical suit; 4 — a layer of a surgical coat; 5— the patient's body; 6 — sweating and the surgeon's micro flora; 7-— the patient's micro flora; 8 — the patient's biological material.

As a result of the study, a complete set of requirements has been formulated according to which a surgical coat should:

✓ provide resistance to penetration of the patient's biological material in the areas closest to the surgeon's working zone (front of the coats and lower sleeves from the elbow to the wrists);

✓ ensure sterility of the back in the body's position when the arms are extended forward (the position in which the surgeon is most often during the operation);

✓ provide sufficient hygroscopicity and vapor permeability to remove vital products (sweat and heat) from the underarm space;

✓ provide barrier properties for aseptic substances and "surgical" infection to contact with the surgeon's skin;

✓ have a rational number of clasps and retainers that should not complicate the process of preparing the surgeon for surgery;

✓ retain the original properties after a set number of purification and sterilization cycles;

✓ eliminate the syndrome of flushing blood colors.

To summarize, one of the ways to obtain high quality medical clothing is to improve the process of its design through a comprehensive approach to the establishment of production and consumer requirements, taking into account the specifics of its use. In accordance with this approach, it has been proposed to structure consumer requirements for medical clothing using a comprehensive approach from the principle of "general to individual". Using the proposed principle, a number of ergonomic studies have been conducted and consumer requirements for surgical coats have been developed taking into account the specifics of the work of medical staff and their individual characteristics. The developed requirements will allow to obtain in the future a number of effective solutions, the implementation of which in industrial production will allow to produce high-quality competitive products.

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ВЛИЯНИЕ ИЗМЕНЕНИЯ ТЕМПЕРАТУРЫ ОКРУЖАЮЩЕЙ СРЕДЫ НА РАБОТУ ИНФРАКРАСНОГО ИЗВЕЩАТЕЛЯ В СИСТЕМАХ БЕЗОПАСНОСТИ

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INFLUENCE OF CHANGES IN AMBIENT TEMPERATURE ON THE OPERATION OF THE INFRARED DETECTOR IN SYSTEMS SAFETY

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Аннотация

В статье приведены результаты исследования влияния температуры окружающей среды на работоспособность инфракрасного извещателя в системах безопасности на основании алгоритма расчета выходного сигнала инфракрасных детекторов. Приведен пример расчета выходного сигнала с детекторов при различных температурах окружающей среды.

Abstract

The results of temperature influence investigation of the ambient on the infrared detector performance in the security systems based on the algorithm for calculating the output signal of infrared detectors, were given. An example of calculating the output signal from detectors at different ambient temperatures is given.

Ключевые слова: инфракрасные извещатели, внешние факторы, выходной сигнал, влияние температуры.

Keywords: infrared detectors, external factors, output signal, temperature influence.

В системах безопасности ИК извещатели используются для своевременного оповещения о проникновении на защищаемый объект. Функционируют ИК извещатели как в условиях естественных, так и искусственных помех, воздействие которых приводит к отклонению от норм их основных параметров. Это, в свою очередь, приводит к ошибкам в